REMARKS

Applicants have amended their claims in order to further clarify the definition of various aspects of the present invention. Specifically, Applicants have amended each of claims 8 and 27 to recite that the semiconductor sample processed has a laminate (structure) of adjacent layers of an aluminum alloy layer and a refractory metal layer on the semiconductor substrate, these layers having different ionization tendencies from each other whereby electrolytic corrosion could be generated and accelerated due to battery action between layers of the laminate. Claims 8 and 27 have been further amended to recite that the etching is performed while applying radio-frequency bias power to the sample; to recite that the sample is transferred from the location where the etching is carried out to a second location where the etched sample is treated by means of a second plasma, through a chamber forming an atmosphere having a pressure reduced from atmospheric pressure; and to recite that the processing steps (i) - (iv) recited are performed using a single sample processing apparatus.

As for use of radio-frequency bias during etching, note, for example, the paragraph bridging pages 19 and 20 of Applicants' specification, particularly together with Fig. 3. As for the laminate being transferred from the first location to the second location through a chamber forming an atmosphere having a pressure reduced from atmospheric pressure, note, for example, buffer chamber 100 in Fig. 3, and the description bridging, for example, pages 14-16 of Applicants' specification. With respect to the steps being performed using a single sample processing apparatus, note, for example, Fig. 3.

Moreover, Applicants are adding new claims 67 and 68 to the application. Each of claims 67 and 68, dependent respectively on claims 8 and 27, recites that the residuals corrosive compounds left on the etched sample, after the etching, includes residual corrosive compounds left in material of the resist mask remaining on the etched sample. Note, in particular, the Example on pages 48-52 of Applicants' specification.

Initially, Applicants respectfully request that the present amendments be entered. It is respectfully submitted that the present amendments clarify the present claims to further support arguments previously made by Applicants, such that the present amendments do not raise any new issues. Clearly, noting portions of Applicants' specification referred to previously, the present amendments do not raise any issue of new matter. Moreover, by further clarifying the definition of the present invention, in light of previous arguments, and providing the same recitations in each of claims 8 and 27, the sole independent claims being considered on the merits in the above-identified application, it is respectfully submitted that the present amendments materially limit issues remaining in the above-identified application; and, at the very least, present the claims in better form for appeal. Furthermore, noting arguments made by the Examiner in the Office Action mailed October 7, 2002, it is respectfully submitted that the present amendments are clearly timely. While new claims 67 and 68 are being added to the application, it is noted that previously finally rejected claims 16 and 66 are presently being cancelled without prejudice or disclaimer, such that after entry of the present amendments, the number of claims in the application will be no greater than the number finally

rejected.

In view of all of the foregoing, it is respectfully submitted that Applicants have made the necessary showing under 37 CFR § 1.116(c); and that, accordingly, entry of the present amendments is clearly proper.

Applicants respectfully submit that all claims now presented for consideration by the Examiner patentably distinguish over the teachings of the references applied by the Examiner in rejecting claims in the Office Action mailed October 7, 2002, that is, the teachings of U.S. patents to Peterman, et al.,
No. 4,855,252, to Moe, et al., No. 4,722,355, and to Noguchi, et al., No. 4,487,678, European Patent Application No. 247,603 (Nakamura), and Elliott, Integrated Circuit Fabrication Technology, pages 56-59, 256, 257, 268, 269 and 272-275, under the provisions of 35 USC §103.

It is respectfully submitted that these references as applied by the Examiner would have neither taught nor would have suggested such a method of processing a semiconductor sample as in the present claims, the sample having a laminate of adjacent films, of an Al alloy film and a refractory metal film, of different ionization tendencies, on a semiconductor substrate, whereby electrolytic corrosion can be generated and accelerated due to battery action between films of the laminate, this process including specified steps of etching the sample having the laminate (more specifically, etching the layers of the laminate in claim 27) through a resist mask, by means of a first plasma while applying radio-frequency bias power to the sample, residual corrosive compounds being left on the sample after etching; and after this step of etching, treating the etched sample by means of a second plasma to remove

at least the resist mask and residual corrosive compounds formed in the etching, with this second plasma treatment (ashing treatment) being carried out at a second location different from the first location where the etching is carried out, the laminate being transferred between the two locations through a chamber having a pressure reduced from atmospheric pressure; and thereafter contacting a surface of the sample with at least one liquid, to remove residual corrosive compounds not removed during the second plasma treatment; and then drying the semiconductor sample, with these processing steps being performed in a single sample processing apparatus. Note claim 8; see also claim 27.

Moreover, it is respectfully submitted that the teachings of these applied references would not have disclosed, nor would have suggested, such a method of processing a semiconductor sample as discussed previously, including removing the corrosive compounds, and wherein the residual corrosive compounds left on the etched sample, after the etching, includes residual corrosive compounds left in material of the resist mask remaining on the etched sample, with these residual corrosive compounds being removed during contact with the liquid (as set forth in claims 8 and 27). See claims 67 and 68.

In addition, it is respectfully submitted that the teachings of these applied references would have neither disclosed nor would have suggested such a method of processing a semiconductor sample, having features as discussed previously, and further including (but not limited to) wherein the atmospheres in which the various steps take place are those set forth in claims 9 and 12-14; and/or wherein the drying uses an inert gas or introduces a dry gas to the sample (see claims 10

and 15); and/or wherein the ashing/treating using the second plasma is performed using oxygen in the second gas in which the second plasma is formed (see claim 11); and/or wherein in the ashing step (treatment by the second plasma) the whole of the resist mask is removed (see claim 17).

The present invention is directed to a method of processing (which includes an etching step) a semiconductor sample having a laminate of an Al alloy film and an adjacent refractory metal film, which are films of materials of different ionization tendencies, e.g., to pattern the laminate, using a resist mask during the etching for patterning the laminate. This laminate structure is especially open to corrosion due to battery action between films of the laminate, including the adjacent films of different materials of an Al alloy film and a refractory metal film. In particular, the present invention is directed to such method, wherein corrosion, including electrolytic corrosion, of the etched semiconductor sample, including the laminate layers, can be avoided. The present invention is particularly suitable for processing a semiconductor sample in the manufacture of semiconductor devices, which processing utilizes a resist mask during the etching, in forming a pattern from, for example, the laminate, overlying a semiconductor substrate.

During such processing, the resist mask can act not only to provide selective etching of the laminate, but also acts to provide a protective film on sidewalls of the etched laminate during the etching. During etching, where the films of the laminate include adjacent films of a refractory metal upper film and an aluminum alloy lower film, the etching speeds are different and a notch or undercut would occur at the aluminum alloy lower film, which has a higher etching speed than the refractory

metal upper film. However, when using a resist, and where a radio-frequency bias power is applied during the etching, carbon and hydrogen of the resist are sputtered during the etching and adhere to the sidewalls of the etched refractory metal and aluminum alloy, for example, thereby providing a protective film on the sidewalls, preventing the notch or undercut. This protective film, made of components of the resist film, is removed during removal of the resist. <u>However, during formation of this protective film, residual corrosive components (for example, chlorides of aluminum, titanium, etc.) are incorporated in the protective film, which is especially detrimental in connection with electrolytic corrosion</u> (discussed further <u>infra</u>).

A corrosion-proofing technique after etching is disclosed, for example, in U.S. Patent No. 4,487,678. This technique subjects a resist film, after plasma etching a layer using the resist as a mask, to removal in a second plasma processing chamber, connected to the etching chamber. The second plasma treatment not only removes the resist film, but also removes chlorine compounds which are corrosive components remaining in the resist films or on the etched surface.

It is also known to heat the sample, after etching, to at least 200°C, in order to promote evaporation of chlorides that are residual corrosive compounds, for avoiding corrosion.

However, Applicants have found that the above-described corrosion-proofing techniques after etching in a plasma are <u>not</u> sufficient for samples having a laminate structure of adjacent films of aluminum alloy and refractory metal, of different ionization tendencies, overlying a substrate, where a resist mask is provided over the laminate structure during the etching. That is, the foregoing corrosion-proofing

techniques fail to provide sufficient corrosion-proofing effect after etching a sample having a laminate structure including adjacent aluminum alloy and refractory metal films, which are adjacent films of materials of different ionization tendencies. See, for example, page 2, lines 11-18, of Applicants' specification. This insufficiency is particularly a problem at present, in view of the materials utilized as a wiring film in integrated circuit devices, and also in view of the increased density (decreased size, including decreased size of the wiring) of integrated circuit devices. As described in the paragraph bridging pages 2 and 3 of Applicants' specification, even if corrosive materials generated by etching are removed by utilizing a plasma at a high temperature of 200°C, corrosion occurs due to the effect of moisture on remaining corrosive compounds, within some minutes or several hours after the sample is withdrawn into the atmosphere.

That is, Applicants have found that in etching the specific laminate structure of the recited materials, using a resist mask, as in the presently claimed invention, a protective film (discussed previously) is formed on sidewalls of the etched laminate structure, and residual corrosive compounds remain in this protective film. This protective film is made of components of the resist; and by carrying out plasma processing for resist removal, residual corrosive compounds in the protective film are exposed to the etched surface, and residual corrosive compounds not removed in the plasma processing for resist removal can cause corrosion of the etched structure.

<u>In addition</u>, a further corrosion problem has been uncovered by Applicants, and arises in connection with treatment of samples having laminate structure

including adjacent films of the recited materials, which have different ionization tendencies. Since the material to be subjected to the etching is a laminate structure, the material is subjected to quick corrosion by an electrolytic corrosion between the adjacent films due to a battery action developing therebetween by the different materials having different ionization tendencies. Particularly where laminated structure, of the recited materials as in the present claims, is processed by etching using a resist, prior corrosion-proofing techniques have failed to provide sufficient corrosion-proofing effect, due to the quick and relatively large amount of electrolytic corrosion.

Against this background, Applicants provide a process which is adequate for corrosion proofing even of the laminate structure including the adjacent films of a refractory metal and aluminum alloy, having different ionization tendencies, after etching such structure using radio-frequency bias potential, and even where a resist mask is used. Moreover, the present process can effectively be used to both provide corrosion resistance and remove a resist film used, for example, for patterning the laminate structure overlying the substrate. Applicants have found that by utilizing, in combination after the plasma etch, a treatment in a second plasma both to remove the resist mask and remove residual corrosive compounds formed in the plasma etching, with the semiconductor sample being transferred from the etching location to the treatment in the second plasma through a chamber forming an atmosphere having an pressure reduced from atmospheric pressure, and then contacting the sample with a liquid (for example, water), with all processing from etching to drying being performed in a single sample processing apparatus, the

objectives according to the present invention are achieved; and, in particular, the laminate structure of the specified materials can be etched using radio-frequency bias potential and a resist, e.g., as a mask, without corrosion of the laminate structure, using a relatively simple apparatus.

It is emphasized that the problem of corrosion is much greater when processing a semiconductor sample having a laminate structure comprising adjacent films of aluminum alloy and refractory material, which have different ionization tendencies, due to, for example, the corrosion generated and accelerated due to battery action between the films of the laminate structure. Notwithstanding this greater problem, which greater problem is unexpected from the applied references, the corrosion problem is unexpectedly avoided, and sufficient corrosion protection can be achieved, by processing according to the present invention. As to unexpectedly better results achieved according to the present invention, note the paragraph bridging pages 7 and 8 of Applicants' specification. Note also, for example, the Example on pages 48-51 of Applicants' specification, particularly Fig. 8 and the description in connection therewith on pages 50 and 51 of Applicants' specification. It is respectfully submitted that this evidence in Applicants' specification shows unexpectedly better results in solving an unexpectedly severe problem, and further establishes unobviousness of the present invention. See In re DeBlauwe, 222 USPQ 191(CAFC 1991).

Elliott discloses various photo-fabrication processes for aluminum etching. This publication discloses a specific procedure including a CF_4 plasma to preclean a wafer and harden the resist; a CCl_4 plasma for aluminum etching; an H_2 plasma to

remove chlorides from the parts and the chambers; and a CF_4:O_2 plasma to remove residual silicon precipitates. This publication then goes on to state that, after etching, occasionally a residue is left on the wafer, confirmed to be Al_2O_3 and SiO_2, and that this residue can be removed by partial dry etching followed by immersing in a wet-aluminum etch. Also described in this publication is that, after aluminum etching with positive photoresist, wafers should be stripped as soon as possible, because some free radicals may be absorbed and this will form hydrochloric acid which will attack the aluminum.

As can be seen in the foregoing, Elliott is concerned with etching aluminum; moreover, this publication refers to an inorganic residue. It is respectfully submitted that the pertinent pages of this publication, as applied by the Examiner, would not have taught, nor would have suggested, etching of laminates having adjacent layers of aluminum alloy and a refractory metal having different ionization tendencies, whereby corrosion could be generated and accelerated by electrolytic corrosion due to battery action between these layers, as presently claimed. More particularly, it is respectfully submitted that Elliott would not have taught, nor would have suggested, the particularly severe corrosion problem arising in connection with plasma etching laminates with adjacent layers of aluminum alloy and refractory metal having different ionization tendencies, particularly where the etching is performed using a resist, or the solution to this problem as achieved by Applicants. Especially since Elliott discloses an inorganic residue, this reference would not have taught or suggested the more severe corrosion problem arising when using a resist.

In particular, it is respectfully submitted that, in Elliott, there is no disclosure,

nor any suggestion, of an electrolytic corrosion problem arising in connection with etching of a laminate of adjacent layers of aluminum alloy and refractory metal, having different ionization tendencies, particularly when a resist mask is used, as in the present claims, or the means for solving this problem as achieved according to the present invention and discussed previously.

Moreover, it is respectfully submitted that Elliott does not disclose, nor would have suggested, treatment of the laminate structure of adjacent films of aluminum alloy and refractory metal, or treatment of such laminate structure with a resist thereon, or wherein the etching is performed while applying radio-frequency bias power to the sample, much less the more severe corrosion problems arising in such processing. Not having even disclosed the problem, it is respectfully submitted that Elliott, either alone or in combination with the teachings of the other applied references discussed infra, would not have taught or suggested the processing according to the present invention, including processing in the single sample processing apparatus, which avoids the severe problem of corrosion.

According to the present invention, during etching of the sample, in which adjacent films of different ionization tendencies of aluminum alloy and of refractory metal are processed, radio-frequency bias power is applied. Accordingly, when ions in the plasma during etching are incident to the sample, the resist mask is sputtered, and further the sputtered resist components adhere to the sidewall of the etching portion to form the protection film. At this time, the chlorine system reaction compounds adhere to the sidewall of the etching portion together with the resist components. The chlorine system reaction compounds, e.g., enter into the sidewall

protection film and become residual corrosion compounds, which are difficult to remove. Thus, the circumstances in general around which severe corrosion problems arise, according to the present invention, are defined in the claims as presently amended; and it is respectfully submitted that the references as applied by the Examiner do not disclose, nor would have suggested the more severe corrosion problems arising in processing as in the present claims, or avoiding such problems by the processing of the present invention, as discussed previously. In this regard, note that using the single sample processing apparatus for all steps from etching to drying, and including the second plasma treatment to remove resist, and the washing to remove remaining residual corrosive components, corrosion is prevented even in light of the more severe environment, in a process which is simple and uses relatively simple apparatus.

It is respectfully submitted that the secondary references as applied by the Examiner, either with or without the teachings of U.S. Patent No. 4,487,678 to Noguchi, et al., would not have rectified the deficiencies of Elliott, such that the presently claimed invention as a whole would have been obvious to one of ordinary skill in the art.

Nakamura discloses a method for stripping a photoresist coated on a layer of an aluminum alloy, formed on a semiconductor substrate. This patent document discloses that such stripping causes corrosion of the aluminum alloy, and describes various known procedures which attempted to prevent this corrosion but which are not successful when an aluminum <u>alloy</u> is etched. This patent document then goes on to describe a method for etching an aluminum <u>alloy</u>, which avoids the corrosion

problem of the aluminum alloy. See, for example, page 3, lines 1-10 of Nakamura. Note also page 3, lines 42-46 of Nakamura, describing transfer of the substrate to a dry processing apparatus (for stripping the patterned photoresist) from the etching apparatus, through a vacuum system or an inert gas purged system to avoid exposure to the atmosphere, avoiding corrosion of the aluminum alloy.

It is emphasized that Nakamura discloses a technique for etching an aluminum alloy. It is respectfully submitted that the teachings of this reference, either alone or in combination with the teachings of Elliott, would have neither taught nor would have suggested the method of etching the laminate with adjacent layers of aluminum alloy and refractory metal of different ionization tendencies, especially wherein the structure processed has a resist thereon, or the other aspects of the present invention as discussed previously, including transfer between the first and second locations through the recited chamber, or use of the single sample processing apparatus, for example. Again, it is emphasized that the combined teachings of these references would have neither disclosed nor would have suggested the particularly acute corrosion problem arising when etching laminates wherein adjacent layers are of aluminum alloy and refractory metal having different ionization tendencies, especially when such laminates have a resist film thereon, and more especially where a radio-frequency bias power is applied during etching, and a solution to this problem as achieved by the present invention.

Moe, et al. discloses a method for stripping photoresist from wafers, wherein the wafers are individually fed through a machine and are first soaked in stripping solution and then subjected to high pressure, high volume flow of stripping solution

over the wafers in a closed environment. The wafers then pass into another housing and are rinsed with alcohol or water and then are passed to another housing where they are dried with heated air or nitrogen. See column 1, lines 28-35.

Initially, it is respectfully submitted that the teachings of Moe, et al., as applied by the Examiner, are not properly combinable with the teachings of Elliott and of Nakamura. In this regard, it is emphasized that Moe, et al. is concerned with a <u>liquid</u> method for stripping photoresist from wafers. The <u>liquid which is the stripping solution</u> is rinsed off. It is respectfully submitted that one of ordinary skill in the art concerned with dry etching and ashing <u>using a plasma</u>, would <u>not</u> have looked to the teachings of Moe, et al. In this regard, it is respectfully submitted that Moe, et al. is directed to a different technology (liquid stripping, as compared with dry ashing) and is concerned with a different problem (effective stripping using a liquid, in Moe, et al., as compared to dry etching and dry ashing procedures in Elliott, as applied by the Examiner, and in Nakamura). In view of these differences in technology and problems addressed, it is respectfully submitted that Moe, et al. is not analogous art in connection with the other applied references; such that one of ordinary skill in the art concerned with in either of Elliott or Nakamura would not have looked to the teachings of Moe, et al.

<u>In addition</u>, it is respectfully submitted that the Examiner has pointed to <u>no</u> proper motivation for combining the teachings of Moe, et al. with the teachings of the other applied references.

Even assuming, <u>arguendo</u>, that the teachings of Moe, et al. were properly combinable with the teachings of Elliott and Nakamura, the combined teachings

would have neither disclosed nor would have suggested the etching of the laminate having adjacent films of aluminum alloy and refractory metal, having different ionization tendencies, much less having the resist on such laminate, or wherein the etching is performed with radio-frequency bias applied, or specific problems arising in connection therewith, which are avoided by the present invention, as discussed previously.

Peterman, et al. discloses a process for making metal contacts self-aligned to interconnecting metallurgy, the process including depositing a layer of polyimide over an insulating layer; depositing a layer of photoresist over the polyimide layer; photolithographically defining a wiring pattern in the layer of photoresist and transferring that pattern into the polyimide layer; depositing a second layer of photoresist; lithographically defining a pattern of contacts in the layer of resist and transferring that pattern into the insulating layer; and depositing a layer of metal which forms the contact studs and interconnect wiring. See column 1, line 56 to column 2, line 2. This patent discloses that the layer of metallurgy is "conformally deposited", the metal layer being blanket etched to the surface of the polyimide layer in a reactive ion etcher. See column 3, lines 46-60. This patent further discloses that the interconnection metallurgy can be any material conventionally used for such purposes, including, but not limited to, aluminum, polysilicon, copper, silicon, titanium, tungsten, silver, gold or alloys or composites thereof. See column 3, lines 47-52.

It is respectfully submitted that Peterman, et al. discloses, e.g., a blanket etch of the interconnection wire. It is respectfully submitted that Peterman, et al., either

alone or in combination with the teachings of the other references as applied by the Examiner, would have neither taught nor would have suggested the severe corrosion problems arising when etching of a laminate of adjacent films of aluminum alloy and refractory metal, of different ionization tendencies, as discussed previously. In addition, the blanket etch of Peterman, et al. would have taught away from use of the resist, and application of radio-frequency bias power, as in the present invention, and corrosion problems arising, and wherein severe corrosion problems arise due to electrolytic corrosion, as discussed supra.

Moreover, it is respectfully submitted that Peterman, et al., either alone or in combination with the teachings of the other applied references, would have neither taught nor would have suggested the particularly acute problem of corrosion arising when etching the laminate with adjacent films of the specified materials, of different ionization tendencies, which is even more severe in processing utilizing a resist and with application of radio-frequency bias power; or avoidance of such corrosion through use of the present method, as discussed previously.

Moreover, it is again emphasized that Peterman, et al. discloses a conformal deposition with blanket etch. It is respectfully submitted that the teachings of this reference, even in combination with the teachings of the other references as applied by the Examiner, would have taught away from etching a laminate as in the present claims, using a resist mask.

Noguchi discloses dry-etching apparatus which can etch aluminum wiring films on wafers of integrated circuit elements, and can provide a post-treatment in which etching resist films are removed, together with the chlorides deposited on the

surface of the wafers during the etching process. The described apparatus provides a structure which can supply dry-etched wafers to a post-treatment stage without removing them into the atmosphere. See column 2, lines 3-6. The structure includes a vacuum antechamber attached to the etching chamber, so that the wafers recovered from the etching chamber can be removed into the atmosphere via the post-treatment chamber. In a specific embodiment shown in Figs. 1-4, this patent discloses dry-etching apparatus provided with a wafer-feed means 1, a first vacuum antechamber 2 which receives a wafer from the feed means 1 and places the wafer in a vacuum atmosphere, an etching chamber 3 which receives the wafer from the first vacuum antechamber and etches it, a second vacuum antechamber 4 which takes the etched wafer from the etching chamber 3 and holds it therein, a post-treatment chamber 5 formed in a lower portion of the second vacuum antechamber 4 which removes chlorides deposited on the surface of the etched wafer, as well as the etching resist film, and a recovery means 6 positioned opposite the second antechamber which receives the post-treated wafer discharged from the second vacuum antechamber 4. See column 2, lines 28-43.

Even assuming, arguendo, that the teachings of Noguchi, et al. were properly combinable with the teachings of the other references as applied by the Examiner, such combined teachings would have neither disclosed nor would have suggested the presently claimed subject matter, having all the features as discussed previously, including etching of the laminate structure having the recited adjacent films of aluminum alloy and refractory metal, with etching being performed using a resist and with radio-frequency bias power applied, and the especially severe corrosion

problem arising in connection therewith; and avoiding such problem by the processing including the second plasma treatment (ashing treatment) at a second location apart from the etching location, with the sample having the laminate being transferred from the first location of the etching to the second plasma treatment location through a chamber forming an atmosphere having a pressure reduced from atmospheric pressure, the processing further including the liquid contact and drying, with all of the etching, treatment with the second plasma, liquid contact and drying being performed in a single sample processing apparatus, thereby avoiding the especially severe corrosion problem, as discussed previously.

Reference by the Examiner in the second line of Item 3, on page 2 of the Office Action mailed October 7, 2002, to Elliott "as applied to claims cited above", is not understood. To clarify the record, Item 3 appears to be the first citation by the Examiner of Elliott, as well as the other applied references.

The contentions by the Examiner in the paragraph bridging pages 3 and 4 of the Office Action mailed October 7, 2002, with respect to combinability of the teachings of the applied references (that is, Elliott, EP 247603, Moe, et al. and Peterman, et al.) are noted. In view of the especially severe corrosion problem arising in connection with processing a laminate of adjacent films of aluminum alloy and refractory metal, having different ionization tendencies, when processing using a resist during the etching and applying radio-frequency bias power during the etching, wherein, inter alia, quick and severe corrosion problems arise due to, for example, battery action, it is respectfully submitted that there would not have been such a reasonable expectation of success as alleged by the Examiner.

The contention by the Examiner in the sentence bridging pages 4 and 5 of the Office Action mailed October 7, 2002, that "mere addition of a resist film can only have the obvious result of preventing etching of the covered areas" is respectfully traversed. To the contrary, as disclosed by Applicants in their specification and as in the present claims, a more severe corrosion problem occurs when etching using a resist mask, due to residual corrosive components existing in a protective film of material of the resist mask on side surfaces of the etched structure. Clearly, use of the resist mask has an "unobvious" result of increasing the corrosion problem, as discussed previously.

Reference by the Examiner to the Decision by the Board in the parent application is noted. Of course, the claims in the <u>present</u> application are <u>clearly</u> different from the claims considered by the Board; and while, of course, the Decision by the Board is to be considered, it is respectfully submitted that this Decision is <u>not</u> controlling with respect to the present claims, having many additional features and clarifications not in the claims considered by the Board.

The contention by the Examiner on page 6 of the Office Action mailed October 7, 2002, that on page 8 of the Amendment filed July 15, 2002, Applicants' representative "misses the mark" in describing the source of the corrosive material, is respectfully traversed. That is, Applicants have noted that during formation of the <u>protective film</u> (this protective film being provided <u>on the sidewalls of the laminate structure</u>), corrosive materials are incorporated. This does <u>not</u> indicate that the source of the materials is produced during <u>resist formation</u>, but rather sets forth that the corrosive materials arise during etching and are incorporated into material of the

resist when the material of the resist forms the protective film, during the etch process, as recognized by the Examiner on page 6 of the Office Action mailed October 7, 2002.

However, Applicants respectfully traverse the conclusion by the Examiner that the prior art of Elliott would have appreciated the incorporation of the corrosive materials into the material of the resist when forming a protective film along the sidewalls of the laminate. That is, it is again emphasized that Elliott discloses a blanket etch, not a patterned etch. It is not seen how, with such disclosure of a blanket etch, Elliott could have described corrosive compounds being incorporated in the protective film along the sidewalls of the etched structure, causing the electrolytic battery corrosion discussed previously. Again, it is respectfully submitted that neither Elliott nor any of the other applied references would have disclosed or would have suggested the problem addressed by the present invention, source of such problem and solution thereto as achieved according to the present invention. Taking the present invention as a whole, including the problem addressed and source thereof, and solution thereto, it is respectfully submitted that the present invention patentably distinguishes over the teachings of the applied references.

The contention by the Examiner in lines 7-10 on page 7 of the Office Action mailed October 7, 2002, is noted. It is respectfully submitted, however, that the Examiner has not established that, from the teachings of the applied prior art, one of ordinary skill in the art would have been motivated to combine all of the after treatments as recited in the present claims. It is respectfully submitted that Applicants disclose the particularly severe corrosion problem; and disclose the

solution thereto, by utilizing the combination of ashing, liquid treatment and drying, with transfer between the location of etching to the ashing location through a chamber forming an atmosphere having a pressure reduced from atmospheric pressure, and with all steps from etching through ashing, liquid contact and drying being performed using a single sample processing apparatus, as in the present claims.

That is, it is emphasized that the various applied references describe that for the procedures disclosed therein, the processing described therein achieves sufficient corrosion protection. In contrast, in taking the present invention as a whole, a semiconductor substrate with a laminate structure of adjacent films of aluminum alloy and refractory metal is etched using radio-frequency bias power, and with use of a resist during etching, causing more severe corrosion problems. The more severe corrosion problems are <u>not</u> disclosed, nor would have been suggested, by the applied prior art. Having discovered the more severe problem, Applicants solve such problem according to the present invention, utilizing the described processing including the recited apparatus. Again, noting the present invention as a whole, it is respectfully submitted that the teachings of the applied prior art would have neither taught nor would have suggested the present invention. That is, without knowing the more severe problems addressed, there would have been <u>no</u> motivation to combine teachings of references as applied by the Examiner.

The obviousness-type double patenting rejections, over claims 1-14 of U.S. Patent No. 5,007,981 or claims 1-6 of U.S. Patent No. 6,077,788, are noted. See Items 6 and 7 on pages 8 and 9 of the Office Action mailed October 7, 2002.

These double patenting rejections are respectfully traversed. It is respectfully submitted that the present claims have many features which would neither have been disclosed nor would have been suggested by claims 1-6 of U.S. Patent No. 6,077,788 or claims 1-14 of U.S. Patent No. 5,007,981. For example, it is respectfully submitted that No. 5,007,981 would have neither taught nor would have suggested such method as in the present claims, including, inter alia, a transfer from the first location to the second location; and/or use of the resist mask; and/or application of radio-frequency bias power to the sample; and/or treatment using a single sample processing apparatus, all of which are in the present claims. Similarly, the claims of No. 6,077,788 would have neither taught nor would have suggested the presently claimed subject matter, including features thereof set forth previously.

Reference by the Examiner to Elliott and Nakamura, et al., in the last paragraph of Item 6, is noted. It is respectfully submitted that reference to these publications, without application thereof in a formal statement of the rejection, is improper. See In re Hoch, 166 USPQ 406, 407 n.3 CCPA 1970). If the Examiner maintains this rejection, it is respectfully submitted that the Examiner must include the publications in the formal statement of the rejection, and establish combinability of the teachings thereof with the subject matter claimed in the U.S. patent applied in the double patenting rejection, in order for the rejection to be procedurally proper.

In view of the foregoing comments and amendments, entry of the present amendments, and reconsideration and allowance of all claims remaining in the application, are respectfully requested.

Attached hereto is a marked-up version of the changes made to the claims by the current Amendment After Final Rejection. The changes are shown on the enclosed Attachment captioned "VERSION WITH MARKINGS TO SHOW CHANGES MADE".

To the extent necessary, Applicants petition for an extension of time under 37 CFR 1.136. Please charge any shortage in fees due in connection with the filing of this paper, including extension of time fees, to the Deposit Account No. 01-2135 (Case No. 503.28546CV9) and please credit any excess fees to such Deposit Account.

Respectfully submitted,

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VERSION WITH MARKINGS TO SHOW CHANGES MADE

IN THE CLAIMS

8. (Three Times Amended) A method of processing a semiconductor sample having a laminate structure comprising [at least two] adjacent films, [of at least two different metals] of different ionization tendencies, of an Al alloy film and a refractory metal film, on [overlying] a semiconductor substrate, whereby electrolytic corrosion could be generated and accelerated due to battery action between films of the laminate, including said [at least two] adjacent films, comprising the steps of:

(i) etching said semiconductor sample having said laminate structure, [including said at least two adjacent films,] using a resist mask, by means of a first plasma formed in a first gas with first processing conditions while applying radio-frequency bias power to the sample, residual corrosive compounds being left on the sample after the etching,

(ii) after step (i), ashing the sample by means of a second plasma to remove at least the resist mask and said residual corrosive compounds formed in step (i), said second plasma being formed in a second gas and with second processing conditions, said ashing being carried out at a second location different from a first location where said etching is carried out, and wherein the semiconductor sample having the laminate is transferred from said first location to said second location through a chamber forming an atmosphere having a pressure reduced from atmospheric pressure,

(iii) contacting a surface of said sample etched in step (i) and ashed in

step (ii) with at least one liquid which effects at least one of (a) removal of said residual corrosive compounds formed in step (i) which were not removed in step (ii) and (b) passivation of said surface etched in step (i) and ashed in step (ii), and

(iv) after step (iii), drying the sample,

wherein steps (i) - (iv) are performed using a single sample processing apparatus.

27. (Three Times Amended) A method of processing a semiconductor sample having a laminate of [at least two] adjacent layers of an Al alloy layer and a refractory metal layer on [overlying] a semiconductor substrate and a resist mask formed on said laminate, said [at least two] adjacent layers [respectively being made of different materials from each other and] having different ionization tendencies from each other, whereby corrosion could be generated and accelerated by electrolytic corrosion due to battery action between layers of the laminate, including said [at least two] adjacent layers having different ionization tendencies from each other, comprising the steps of:

(i) etching [each of] said [at least two] layers of said laminate through said resist mask, by means of a first plasma, so as to form an etched sample having an etched shape which corresponds to a pattern of said resist mask, while applying radio-frequency bias power to the sample, residual corrosive compounds from the etching being left on the etched sample;

(ii) after step (i), treating the etched sample by means of a second plasma, to remove said residual corrosive compounds formed in step (i) and to

remove said resist mask, said treating being carried out at a second location different from a first location where said etching is carried out, and wherein the semiconductor sample having the laminate is transferred from said first location to said second location through a chamber forming an atmosphere having a pressure reduced from atmospheric pressure;

(iii) contacting a surface of said semiconductor sample etched in step (i) and treated in step (ii) with at least one liquid, to remove said residual corrosive compounds which were not removed in step (ii); and

(iv) after step (iii), drying the semiconductor sample,

wherein the steps (i) - (iv) are performed in a single sample processing apparatus.